Carbon ‘hotspots’ in global supply chains: an inter-regional input-output analysis

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Introduction

- Input-Output analysis has been widely used to study the environmental impact of human economic activities
- **The purpose of this study is to identify CO_2 ‘hot-spots’ in global supply chains using Inter-Regional Input-Output analysis**
- For this study as ‘hot-spots’ are defined
  - Sectors with significant volume of direct emissions
  - Sectors with significant emissions embodied in inputs used (attributed to final demand)
  - Specific transactions between sectors that embody large volume of CO_2 emissions

Environmental IRIO

$$Cfl_{IRIO} = E_{IRIO}\left(I - A\right)^{-1} D_Y = \begin{bmatrix} e_i^1 l_{ij}^{11} y_j^1 & \cdots & e_i^1 l_{ij}^{1s} y_j^s & \cdots & e_i^1 l_{ij}^{1T} y_j^T \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ e_i^r l_{ij}^{r1} y_j^1 & \cdots & e_i^r l_{ij}^{rs} y_j^s & \cdots & e_i^r l_{ij}^{rT} y_j^T \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ e_i^T l_{ij}^{T1} y_j^1 & \cdots & e_i^T l_{ij}^{Ts} y_j^s & \cdots & e_i^T l_{ij}^{TT} y_j^T \end{bmatrix}$$

- In the Carbon flow matrix (Cfl) each element $e_i^r l_{ij}^{rs} y_j^s$ tells *us the emissions generated in sector i in region r to meet the total final demand requirements for output j originating in region s*
- Cfl includes all the transactions between the industries included rather than aggregates

Data

- OECD Inter-country Input-Output Database
- 57 countries plus ROW, 37 sectors
- IEA fuel combustion data and UNFCCC

‘Hot-spot’ detection

Table 1. Example of hot-spot detection

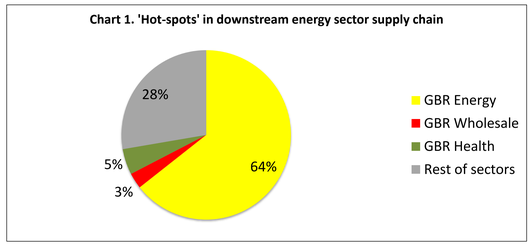
	Wholesale	Hotels	Transportation	Telecomms		Total Emissions
Wholesale	31.91	2.09	0.33	0.31		34.63
Hotels	0.06	14.93	0.01	0.00		15.00
Transportation	19.40	4.52	54.46	1.34		79.73
Telecomms	0.45	0.25	0.09	2.96		3.75
Inputs' Emissions	51.82	21.78	54.89	4.61		

- Transportation is the highest direct emitter and has the highest emissions attributed to final demand with Wholesale being a close second
- Although two interactions are marked as ‘hot-spots’, the analytical nature of the matrix indicates that the transportation required for wholesale is also a point that might need consideration

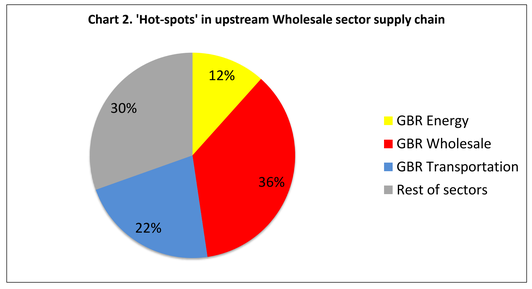
Overview of results

- **85% of emissions located on main diagonal of Cfl where r=s, i.e. are used to meet the final demand of industries within the same country**
- 85.9% of UK sectors embodied in goods used as inputs of other UK sectors or final goods, regardless of consumer’s location
- 78.1% of UK territorial emissions generated to meet demand of UK consumers (using UK final demand)

UK ‘hot-spots’



- **Energy the top direct polluting UK industry**
- Majority of emissions to meet own final demand
- Two more ‘hot-spots’ in energy used to meet Wholesale/Retail and Health final demand
- **Total emissions/value added for energy sector indicates better benefit to risks ratio compared to the other sectors**
- ‘Hot-spots’ suggest benefits by improving energy efficiency of Wholesale/Retail and Health sectors



- Wholesale/Retail shows significant difference between emissions embodied in inputs (88.59 Mt of CO_2) and direct emissions (50.81 Mt of CO_2)
- **3rd in emissions attributed to final demand among UK sectors**
- **‘Hot-spots’ indicate benefits by reducing energy used and transportation needs**
- Emissions/ Value-added suggests energy sector reform to be the less risky option, followed by changing the use of transportation
- Wholesale/Retail production includes the operation of autoproducing power and heat plants in the premises of the branches, warehouses etc.

General

- **No UK ‘hot-spots’ outside UK borders, embodied either in inputs or exported intermediate goods**
- UNFCCC is likely to continue using a territorial Production Accounting Principal approach
- Findings show that this approach could address most emissions generated by human economic activities

Conclusions/extension

- Methodology followed provides a clearer picture of the elements that contribute to the total emissions both direct and attributed to final demand
- It is possible to pinpoint specific points where interventions could have most effective
- Solutions could be found both on the producing and the consuming side and that can be seen using the proposed methodology
- Potential extension involves drilling down to local level
- Local level data can be used to guide physical measurements to assess the present impact of the activities on the environment